From the External Gun To the Hybrid Tank

by Robin Fletcher


TACOM's Tank Test Bed Vehicle

Designs for armored fighting vehicles are now being put forward which are to be operated by only two crewmen seated down in the hull.

Both the German E.G.S.[1] and the British VERDI 2[2] experimental vehicles employ this new system of crewing. It has been proposed for a further development of the German Leopard 2 Main Battle Tank (MBT)[3], and in the United States, General Dynamics Land Systems (GDLS) is proposing a low profile Future MBT to be operated by only two hull-seated crewmen.[4]

Some of the reasons given for this change in crewing are the need to reduce the vehicle's presented frontal area — particularly that of its turret — so as to reduce the size of target exposed to enemy fire; the need to increase the passive protection provided for the crewmen; and the desire to put the fewest crewmen at risk when the MBT goes into action. A further reason, often not sufficiently appreciated, is that by seating the MBT's two principal crewmen side-by-side in duplicate forward-facing hull crew stations, either one of them would be able to drive.

This would eliminate the third crewman, the dedicated driver, conventionally seated at the front of the vehicle. The resultant vehicle would have smaller dimensions and the possibility of better protection. The three functions of driving, gunning, and commanding would then be exercised by only two crewmen, working together. They could exchange functions as the tactical situation developed. The fact that only two crewmen would then be involved in the operation of the vehicle, rather than a crew of three or even four, should result in an enhanced speed of reaction.

Image intensification and thermal imaging night vision devices have been introduced into many fighting vehicles over the past two decades, so that it has now become possible to maneuver and fight 24 hours a day. Whether a hand-loaded MBT is manned by four crewmen, or whether the introduction of automatic loading allows the number of crewmen to be reduced to only three (e.g. Russian T-80 and French Leclerc MBTs), the vehicle's crew members will all have to remain on duty continuously and all will become equally exhausted. A two-man crew is likely to suffer even more severely during round-the-clock operations, reducing the time a two-man crew can keep going.

If a two-man crew is to be adopted, back-up crews might be one answer, with the off-duty crewmen, transported and protected in some form of light armored vehicle (LAV) for adequate rest and sleep. These LAVs will then have to meet up with the MBTs so that crew exchange can take place, something not easily arranged in a war of maneuver in which vehicles will be well dispersed.

An alternative solution would be to carry a third crewman, resting and sleeping within the hull of the MBT. The three crewmen, who would all be trained to undertake any task in the vehicle, could take turns manning the two principal hull crew stations. Changeovers every four hours, on an agreed schedule, would ensure that the MBT would always be manned by two alert crewmen. The size of the hull would have to increase to accommodate the third resting crewman so, for a given weight of vehicle, there would be less protection.

Loss of Direct "Top Vision"

The MBT's main armament would then be traversed above the hull-seated crewmen, either in an unmanned turret or on an external overhead mounting. An unmanned turret will — like the manned turret preceding it — carry the gun trunnions over the front of the turret ring so the breech can descend into the hull when the gun is put into elevation. An unmanned turret will provide protection for the gun and its recoil system, and rounds will be supplied to the breech within the same armor protection. Examples are the American Tank Test Bed vehicle of the 1980s[5] and Western Design Corporation's winning entry in *ARMOR*'s 1993 Tank Design Contest[6] (See *ARMOR*, July-August 1993).

On the other hand, with an external overhead mounting, the gun trunnions can be above or even to the rear of the mounting's center of traverse so that the breech will not descend into the hull on elevation. Instead, it will move in elevation and depression to the rear of the mounting. Although the external overhead mounting is likely to present a smaller target than the unmanned tur-

ret, it offers less protection to the gun and its recoil system, and rounds supplied externally to the breech are likely to be vulnerable. Examples are the German VTS experimental vehicle of the 1970s, which carried a 105mm tank gun externally above a Marder hull, and the Swedish UDES-19 proposal of the 1980s, in which individual rounds were moved to the breech externally from rear hull stowage while the gun remained pointing at the target.[7]

In the case of a conventionally turreted vehicle, whether hand or automatically loaded, the commander has been able to look all around directly from the highest point of his vehicle, head out, with raised hatch or through his vision cupola, using a wide field of view through the unity periscope.

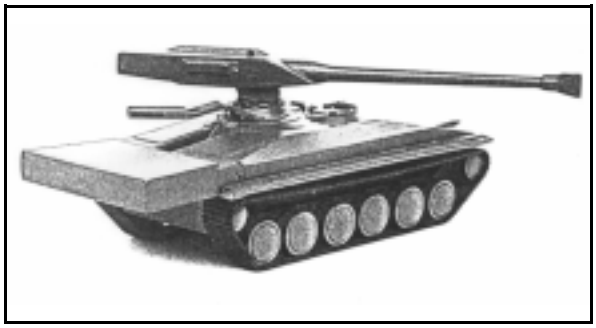
At the same time, he is likely to be provided with a high powered panoramic instrument with which to search for and identify targets, and he may then be able to make use of that same instrument for target engagement. While using this high powered instrument, he will be fully aware that he will be unable to maintain watch all around his vehicle and that there will be a danger that it will be surprised and destroyed.

A major disadvantage of allowing the main armament to traverse above the hull-seated crewmen is that the commander will no longer be able to exercise direct "top vision." He will only be able to look around from the hull roof below the level of the gun.[8] When moving over rolling country with the gun in an unmanned turret or on an external overhead mounting, the gun is likely to be spotted by the enemy before our vehicle commander is in a position to see him.

In the January-February 1996 issue of *ARMOR*, Don Loughlin, in his article, "The External Gun Turret: Often a Bridesmaid, Never a Bride," points out this considerable disadvantage. He notes that such external mountings have often been proposed but have never as yet been adopted, principally because of the absence of commander's direct "top vision."

Reinstatement of "Top Vision"

One way of overcoming this disadvantage is by restoring the vehicle commander's all-around vision to the highest point of his vehicle, if not on a permanent basis then at least temporarily. When the articulated UDES-XX-20 tank destroyer was under development in Sweden[9] in the 1980s, the disadvantage was recognized and steps were taken to overcome it — the vehicle commander, complete with his vision cupola, could be raised and lowered in an armored "capsule." In this way, he could reestablish direct all-around vision above the level of the gun. But the capsule could be only lightly armored, and had to be lowered again for the gun to regain its all-around traverse.



Two Swedish concept vehicles, the UDES-19, at left, seen in model form, and the articulated UDES-20, above, were external gun designs. The arm seen at the base of the UDES-19's gun pedestal was the device used to transfer ammunition from the hull to the rear of the gun.

A sensor head offers another approach to obtain commander's "top vision" indirectly. It would be carried on top of the mounting. But this change from direct to indirect vision may not be entirely satisfactory. As Don Loughlin writes in his article, "thermal imaging ... can't replace the human eye in three respects: resolution, field of view (and the combination of both) and its marvelous working with the brain."

It may be possible to use a tall optical periscope, set in the hull roof, to obtain adequate resolution for target identification, but it will be difficult to use such an instrument to lay the gun. Sighting would probably have to be done by television or thermal imaging from a sight head carried on the gun mounting. This would supply a sight picture to the screens in front of both crewmen. It might also be possible to employ a continuously rotating panoramic head, carried above the mounting, to record the 360-degree scene around the vehicle, but it would be difficult to show a wide portion of that scene to the crewmen if space restrictions limited each man to a single display screen.

A Helmet Mounted Display (HMD) system, worn by all crew members, might allow a 40- to 60-degree field to be obtained from the sensor head above the gun mounting. It would be directed entirely by head movement — a restricted field perhaps, but quickly and instinctively traversed.

It can be argued that such indirect vision will soon become essential if Directed Energy Weapons (DEW) are introduced. If that becomes the case, similar indirect vision will then have to be provided for all classes of fighting vehicles, whether they are turreted or carry their guns in fixed mountings. If this were to occur, the indirect vision of an MBT-equipped with an external overhead gun mounting, while not wholly satisfactory, would certainly not be inferior to any other gun mounting configuration. In that event, the loss of commander's direct "top vision" would no longer be the chief reason to reject the external overhead mounting, and criticism would then be transferred to two other disadvantages.

The first of these is that the external mounting, being above and distinct from the hull of the vehicle, will be easily spotted and identified by the enemy. The second criticism will be the vulnerability of the gun, its recoil system, and the mechanism transferring rounds externally from rear hull stowage to the breech. As Don Loughlin writes in his article, "Elevated gun position decreases survivability due to high silhouette and exposed mechanisms." Clearly, steps will have to be taken not only to counter the vehicle commander's loss of direct "top vision," but also the external mounting's vulnerability. Fortunately, it is possible to overcome all three of these disadvantages simultaneously by the adoption of an unconventional system of mounting the gun.

The low position of the hull-mounted gun in the S-Tank required the tank to be almost fully exposed when firing over cover.

Creating the Hybrid Tank

If we lower the MBT's long tank gun into a depression running the full length of the roof of the hull, the vehicle commander would regain his direct "top vision" and the mounting's vulnerability would be corrected. Moreover, if such a vehicle were then able to be traversed on its tracks and inclined back and forth on a controllable suspension system, it would be able to engage targets with its gun held in its lowered position. Such a vehicle would have to incorporate two very different vehicle configurations, each having very different attributes. Both should now be examined individually in some detail before they are put together to form the hybrid.

The first configuration is the Swedish "S" Tank, developed in the 1960s and only now being withdrawn from service. Traversing was difficult in this fixed gun tank because of the need to employ the differential action of the tracks to turn the whole vehicle. This MBT concept has not been accepted by other nations. Yet the commander's direct "top vision" is available from the hull's highest point, the vehicle is compact and is in no way prominent and, with the gun and its recoil system contained within armor, they cannot be considered vulnerable. The "S" Tank's front engined layout provides good protection for the crewmen at the front and for the ammunition at the rear, but just like a conventional turreted tank, the S" Tank displays a large target to enemy return fire when engaging over cover.

Like the "S" Tank, an MBT carrying its gun on a permanently raised external overhead mounting would be likely to accommodate the crewmen in a front engined hull, with ammunition carried at the rear. The gun would have 360-degree traverse for the rapid engagement of flank targets, but commanders' direct "top vision" would no longer be available. As already noted, the gun on its mounting would be bound to be prominent, and it would also be vulnerable as would the transfer mechanism needed to bring rounds from rear hull stowage to the breech. The mechanism's most difficult task would be to reload the gun while it remained directed at a flank target, although this was, in fact, the solution adopted by the Swedish UDES-19 experimental vehicle. The mechanism's task would be eased considerably if the gun were to return momentarily to the 12 o'clock position after each shot, as the rounds would only need to be raised and rammed forward, and would not also have to be traversed around into alignment with the gun.

When moving in open country, the vehicle carrying an external mounting is likely to present the same size target as the "S" Tank, but when engaging from behind a crestline or rise in the ground, the size of target exposed would be very much reduced.

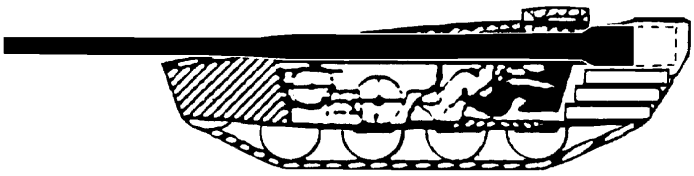
If the permanently raised external overhead mounting were replaced by a mounting which could be moved up and down, or rather by a "lift-and-turn" mounting which could both raise and traverse the gun, the vehicle could engage targets in any direction once the gun was raised. After firing, the gun would not only be returned to the 12 o'clock position, but would also be lowered down into its hull top depression where it would be reloaded by the automatic loading system carried in the rear of the vehicle. Once reloaded, the gun could again be raised and traversed.

While the gun is raised, the vehicle commander's direct "top vision" would no longer be available and the gun, now well above the hull, would be vulnerable. But this would be so only momentarily, while the gun was actually being fired, and the commander would surely minimize the time during which the gun remained raised and exposed.

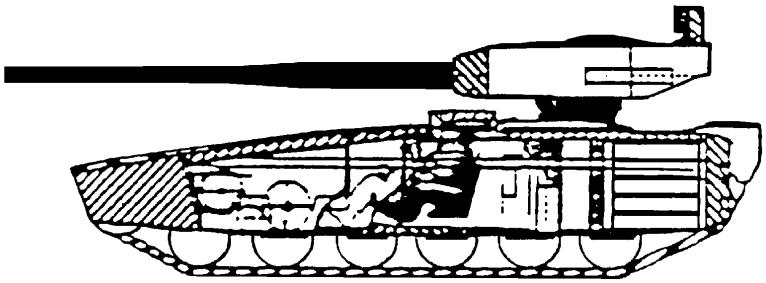
Operating the Hybrid Tank

The Hybrid Tank would be capable of two different modes of operation, employed according to the prevailing tactical situation. It would normally be operated with its gun lowered, giving its commander his vital "top vision" from within his well-protected vehicle. The principal use of the raised gun would be for the engagement of emergency flank targets, but it would also be used for firing on the move, or to display a much reduced target when engaging from behind cover.

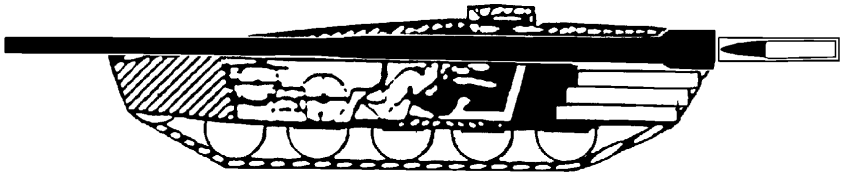
One set of attributes would then be in use when the gun was raised and another when it was lowered, but what amounts to a third set would become available due to the actual raising and lowering of the mounting. Thus, when engaging from behind a crestline, not only would the size of target exposed be minimal, but exposure time would also be short. This makes it difficult for the enemy to hit the much smaller target, gives him little time to do so — the latter depending on his gunner's speed of reaction and the time of flight of his projectile. Moreover, there would be no need for the Hybrid Tank to move forward to put its gun into action or reverse to break off the engagement, as is the case with a conventionally turreted vehicle. It would simply remain



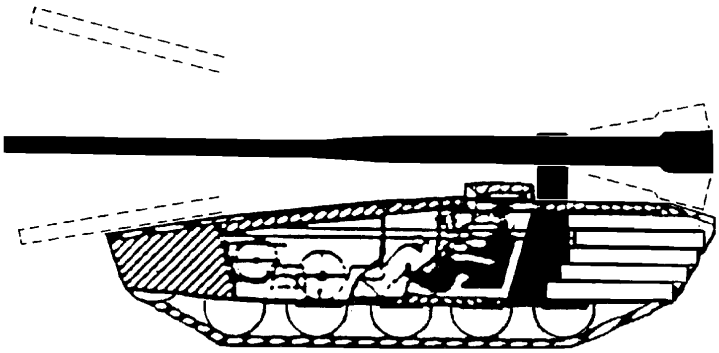
"S" Tank configuration.



External overhead gun configuration.



Hybrid Tank — gun lowered — loading.



Hybrid Tank — gun raised — traversing.

stationary behind the protective crest and raise and lower its gun as necessary.

A Hybrid Tank would have two different means of traverse, on its tracks and by the use of its raised mounting, and also two different means of elevation and depression, by means of its controllable suspension system and again by the use of its raised mounting. This would allow engineers to reduce the scope of either system as the other would be available to supplement it. For instance, a lengthened hull might be difficult to turn on its tracks, but the gun could be traversed on its mounting if necessary, and if the raised mounting was unable to provide enough depression, the suspension could be "knelt" to supplement it. In the extreme, the complete failure of one system need not lead to the Hybrid Tank becoming unserviceable; the other system could be used temporarily, although no doubt with reduced efficiency.

The "lift-and-turn" mounting would be installed behind the crew stations but forward of the stowed ammunition and, just like the vehicle's power pack, should be able to be removed from the hull as a single unit for maintenance or modification. With the breech at the extreme rear of the vehicle, recoil would take place behind it and rounds would be moved out of the rear of the hull before being moved over onto gun centerline to be loaded. The decreased inertia of the gun in traverse would allow the rapid engagement of flank targets and, while lowered, the gun would be supported in the hull top depression to ensure its correct alignment with the automatic loader. Thus the same loading system would reload the gun in whichever mode it happened to be operating with the breech being held close to, or actually being brought to, the ready rounds rather than rounds being conveyed to a distant breech.

An alternate that has been suggested[10] calls for the lowered gun to be carried on one side of the hull, or over one of the vehicle's tracks, rather than in a hull top depression. It would be protected from flank fire by armor carried on the sides of the vehicle. The two crewmen operating the vehicle would then no longer be separated by the gun tube depression in the hull roof between them. They would be able to sit shoulder to shoulder for improved cooperation, and would be able to use

Continued on Page 50

THE HYBRID TANK, *Continued from Page 25*

common displays and controls mounted between the two crew stations. Also, the roof of the hull, not having a central depression, could be better protected against top attack weapons.

Conclusions

- The relocation of two crewmen to fixed hull crew stations will separate them from their main armament, which will then either be carried on an unmanned turret or on an external overhead mounting.
- As pointed out by Don Loughlin, the commander will then no longer be able to exercise direct "top vision" from the highest point of his vehicle, and the external overhead mounting will be both prominent and vulnerable. No wonder that it has been often proposed and just as often rejected.
- But, if the introduction of a 'lift-and-turn' mounting were to allow the characteristics of the fixed gun "S" Tank to be combined with those of a similar front-engined vehicle carrying its gun on an overhead mounting, the resultant hybrid would be able to employ the characteristics of either of these configurations according to the prevailing tactical situation. Such a Hybrid Tank would also only display a small target, for only a short time, and without any vehicle movement when engaging from behind a crestline.
- With the three main disadvantages of the external overhead gun mounting thus corrected, and with advantages gained when engaging from behind cover, the Hybrid Tank might well form the basis of our future main battle tank.

Notes

[1]Robin Fletcher, "The Arming of Crew-in-hull AFVs," *Military Technology*, 7/1995, p. 32 for a photograph.

Hermann Sitterberg, Division K.G., B.W.B., *Military Technology*, Special Issue "B.W.B. - Defence Procurement in Germany," 1994, p. 41 for a description.

[2]Robin Fletcher, "Crew-in-hull A.F.V. Concepts," *Military Technology*, 10/1994, p. 27 for a photograph.

Christopher F. Foss, *Jane's Armour and Artillery*, 1994-95, p. 220 for a description.

[3]Rainer Glass and Rolf Hilmes, "Shaping Germany's Leopard 2 Tank for the Future," *International Defense Review*, 5/1995, p. 62.

[4]Barbara Starr, "GDLS briefs U.S. Army on low-profile tank," *Jane's Defence Weekly*, 28 February 1996, p. 5.

[5]Richard M. Ogorkiewicz, *Technology of Tanks*, Jane's Information Group, 1991, p. 398 for a photograph.

Dr. Asher H. Sharoni and Lawrence D. Bacon, "Ammunition Loading Systems for Future Tanks," *ARMOR*, March-April 1995, p. 17 for a description.

[6]Western Design Corporation, "We have a winner!," First Place in *ARMOR's* Tank Design Contest, *ARMOR*, July-August 1993, p. 7.

[7]Ogorkiewicz, p. 124 photograph and description.

[8]Rolf Hilmes, *Main Battle Tanks - developments in design since 1945*, translated by Richard Simpkin and published by Brassey's Defence Publishers, 1987, scope and limits of future tank development, p. 108.

[9]Ogorkiewicz, pp. 119 and 274 for photographs and p. 395 for a description.

[10]Board on Army Science and Technology of the National Research Council (U.S.) in their report, "STAR 21: Strategic Technologies for the Army of the Twenty-First Century," National Academy Press, 1992, pp. 80-81.

Robin Fletcher was commissioned in the Westminster Dragoons in 1941 and later served in the Special Operations Executive and 2d Special Air Service Regiment. After the war, he attended the technical staff officer's course at Shrivenham, spent two years on tank design at Chobham, and returned to Shrivenham to lecture on tank armament. After leaving the service, he raised crops in Kenya and cattle in Ireland. His articles on armor have been published in *International Defense Review, Soldat und Technik, Military Technology,* and other journals.